TITLE: MODULAR CONSTRUCTION SYSTEM FOR FLOATING STRUCTURES SUCH AS BOATS

Field of the Invention

This invention relates to a modular construction system for floating structures. The invention has been arrived at in the course of developing a system for boat construction using components made of synthetic plastics material formed by the rotational moulding process. However, the application of the invention is not limited to boats. The invention has application to floating platforms, floating storage vessels and the like.

Background of the Invention and Prior Art

Small boats such as kayaks, surf boards, runabouts and similar pleasure craft comprising one piece hull-and-deck units for have been constructed of rotationally moulded plastics for some time. In a rotational moulding process, medium density polyethylene or other suitable plastics material in powder form is introduced into a female mould having the inverse shape of an article to be moulded. The mould is then rotated while being heated, typically being located in an oven for this purpose. Initially the powder is fluent and flows over the interior surface of the mould. When the mould surface reaches the correct temperature the particles of powder at the surface begin to melt and adhere to the surface. As heating continues, more of the particles melt, adhering to each other and eventually forming a layer of uniform thickness on the surface of the mould. This layer solidifies to form the hollow shell-like moulding when the mould is allowed to cool.

Rotational moulding techniques are well understood and need not be described in further detail herein. It is believed that polyethylene is used for the moulding of most

of such known craft although other plastics materials may be suitable. The advantages of the use of polyethylene and other such materials for moulding boats and other articles are well known. Such boats are generally perceived, probably with justification, as being inexpensive and tough. Moreover, the density of polyethylene and the other plastics materials used for rotational moulding is less than that of water so that small boats made by this process have greater inherent buoyancy than boats that are made of, for example, aluminium or GRP (glass-fibre reinforced plastics resin).

From a marketing point of view, the appearance of objects made by known rotational moulding techniques is often seen as a disadvantage for boats built for the leisure industry. However, for fishing boats and boats used for some other commercial purposes, this may be less important. The company with which the applicant is associated has for some time produced small fishing boats of up to 6 meters in length having one-piece rotationally moulded hull-and-deck units. The size of such units is limited, in principle, by the size of available heating ovens used in the moulding process. From a business point of view, it would be very risky at the present time for an enterprise to incur the expense of a large size such oven in the absence of an established market for boats of, say, 10 meters in length with rotationally moulded, one piece hull-and-deck units.

The present invention is an attempt to address this issue, at least to some extent.

Statements of Invention

According to the invention there is provided assembly of mouldings that can be joined together and used as a floating structure, the assembly comprising a first moulding and a second moulding each of which is produced by a rotational moulding process and has an outer face incorporating a first zone and a second zone which zones are so shaped that the first moulding can be joined to the second moulding in a

first disposition in which the first zone of the first moulding is in face-to-face relationship with one of the zones of the second moulding or in a second disposition in which the second zone of the first moulding is in face-to-face relationship with one of the zones of the second moulding.

Further according to the invention, the assembly of mouldings include a third moulding having an outer face incorporating a first zone and a second zone which zones are so shaped that the third moulding can be joined to the second moulding in a first disposition in which the first zone of the third moulding is in face-to-face relationship with one of the zones of the second moulding or in a second disposition in which the second zone of the third moulding is in face-to-face relationship with one of the zones of the second moulding.

According to one aspect of the invention, the first zone and the second zone of each moulding comprise each a flat portion of the outer face of the moulding, the flat portions being disposed at an angle one to the other.

According to another aspect of the invention, the mouldings have outer profiles that are substantially similar one to the other. The advantage of this provision is that it is likely to reduce the cost of producing a boat or other floating structure that incorporates the assembly of mouldings. Such mouldings can, for example, be produced from a single mould, and the cost of two moulds is avoided. Clearly, mouldings that are produced from a single mould will have substantially identical profiles when they are taken out of the mould. Equally clearly, in any structure, the outer profile of a moulding may be modified after it is taken out of the mould. For example, in the case of a boat, holes may be cut in a moulding for the purpose of providing hatches, portholes and the like. For the purposes of this specification and the claims, the alteration of the outer profile of a moulding by the provision of such is not considered to be substantial.

Similar considerations apply to other minor modifications to mouldings.

Advantageously, according to the invention, the three mouldings may have substantially similar outer profiles of hexagonal shape. A hexagonal profile will thus be made up of six straight portions with the adjacent portions being disposed at equal angles one to the other.

The provision of similar mouldings with hexagonal outer profiles leads to the possibility that a number of such mouldings can be joined together in a wide variety of configurations in each of which one of the flat-faced portions of one moulding is disposed face-to-face with one of the flat-faced portions another moulding. Mouldings produced from a single mould, and therefore incorporating substantially similar flat-faced portions can therefore be used to produce a variety of boats and other floating structures.

In another aspect of the invention, at least one moulding has an end face that is disposed in face-to-face relationship with an end face of a fourth moulding to which said at least one moulding is joined. Joining the mouldings together end to end enables boats and other floating structures of increased to length to be produced from rotationally moulded mouldings whose length is limited by the size of the equipment that is available for the moulding process.

Advantageously, according to the invention, the mouldings are of moulded plastics material.

The scope of the invention extends to a hull-and-deck structure comprised of an assembly of the mouldings.

Description of Embodiments Illustrated in the Drawings

Examples of apparatus that embody the invention are described below with reference to the accompanying drawings in which:

Figure 1 is a side elevation of the hull-and-deck assembly of a twin hulled boat, or catamaran, incorporating a number of modular mouldings;

Figure 2 is a side elevation of a pair of the mouldings shown in Figure 1 in their working disposition;

Figure 3 is a side elevation, on Arrow A in Figure 4, of three of the mouldings shown in Figure 1, also in their working disposition;

Figure 4 is a plan view of the hull-and-deck assembly shown in Figure 1;

Figure 5 is a plan view of the pair of mouldings shown in Figure 2;

Figure 6 is a plan view of the mouldings shown in Figure 3;

Figure 7 is an isometric view of the two mouldings shown in Figure 2, with one moulding, only part of which is illustrated, detached from the other;

Figure 8 is an isometric view, similar to Figure 7, of two of the mouldings shown in Figure 3;

Figure 9 is an isometric view of two of the mouldings shown in Figure 3;

Figure 10 is a rear end elevation (on Arrow B) of the hull-and-deck assembly shown in Figure 1;

Figures 11-13 are enlarged details of possible joints between two mouldings;

Figure 14 is an end elevation of a hull-and-deck assembly for a trimaran-type boat;

Figures 15-16 are views of assemblies of mouldings that can be used as floating platforms;

Figure 17 is a view of an assembly of other mouldings that can be used as a floating structure; and

Figure 18 is a fragmentary view of an optional modification to a moulding.

For the sake of avoiding repetition, in this specification the use of the phrase "in the present example" or words to the same effect is intended to indicate that what is being described is by way of illustrative example. In such cases it should be clear from the context that what is being described can be changed and that there is no intention that the scope of the invention be limited thereto. The nature of many of such changes should also be clear to the instructed reader. On the other hand, there is no intention that, in the absence of a phrase of the same kind, the scope of the invention is to be limited to any matter described unless this appears from the context.

It will be clear to the instructed reader that the drawings show, essentially in schematic form, the disposition of the mouldings when they have been assembled together to form examples of floating structures and, more particularly, of boats. The mouldings of the type described herein may be of medium density polyethylene but they could be of any other suitable material suitable for being used in rotational moulding techniques. Such materials include PVC, cross-linked polyethylene and even concrete. As has already been stated, rotational moulding techniques are well understood. No claim is made that the use of a rotational moulding process, or of any materials used in the process, is in itself inventive for producing boats.

Equally well understood are the components such as the engines, internal and external fittings and furniture, ground tackle, navigation equipment, fishing gear etc, and the manner of installation of all of these, that are required to turn a hull-and-deck assembly into a working boat. Again it is not considered necessary to describe these matters herein in detail as they do not form part of the invention..

Referring now to the drawings, there is shown a hull-and-deck assembly 10 that can be fitted out to form a twin-hulled boat or catamaran. To avoid repetition, it will be convenient to refer to this particular boat as boat B even though the finished boat is not shown in the drawings.

In Figures 1-6 , 10 the mouldings are shown slightly separated from each other in some places. This is for clarity of illustration. In reality, the mouldings are structurally joined to each other face to face in these places.

In the present example, the assembly is made up of eight mouldings, each of which is of polyethylene material and is produced by a rotational moulding process using suitable moulds. It is an inherent feature of any article produced by a rotational moulding process that, when it emerges from the mould, it comprises in essence a hollow shell that is fully closed except for one or more small vent holes necessary for allowing gases evolved in the process to escape. One advantage arising from the use of such mouldings for building boats is that they are inherently watertight and thus capable of floating. Holes, some examples of which will be described, may be cut in all of the mouldings in the course of construction of the boat B. Some of these holes are quite large and, unless they are closed by watertight doors or the like (a technique well known in ship- and boat-building techniques), will reduce the floatability of the individual mouldings. Nevertheless, as should be obvious, the fact that the mouldings are initially enclosed facilitates the design and construction of a boat that is less prone to sinking in rough weather or when holed. The floatability is aided by the fact that

the density of polyethylene is lower than that of water. The material itself is thus buoyant.

As already noted, the mouldings that are produced from any one mould will be mutually identical, at least in the state that they are in when they emerge from the mould. Thus, in the case of the assembly 10, there is one group M1 comprising three mutually identical mouldings produced from one mould; a second group M2 comprising two mutually identical mouldings produced from a second mould; another group M3 comprising two mutually identical mouldings produced from a third mould; and a single further moulding produced from a fourth mould M4. All of these mouldings will be described. Since the mouldings in each group of the groups M1-M3 are identical, for most purposes herein only one of the mouldings in each group need be described.

An important feature of the six mouldings in the groups M1, M2 and M4 is their mutually similar athwartships outer profile which, in the present instance, is hexagonal although a variety of other shapes, some examples of which are illustrated and/or described herein, could be used. The hexagonal shape can be seen in Figures 10, 14-16. All such profiles are of constant size over the entire length the mouldings. Thus each of the mouldings in the groups M1-M3 comprises a longitudinally extending, cylindrical side wall 12 of hexagonal cross section having six flat, rectangular segments 14A, 14B, 14C, 14D, 14E, 14F that are disposed at 120° one to the other. The segments are of equal size and extend in the fore-and-aft direction from one end of the moulding to the other end. Each segment has a flat outer face.

Each moulding 16, 18, 20 in the first group M1 comprises a flat front wall 22 spanning the front end of the moulding and a flat back wall 24 spanning the back end of the moulding. The walls 22, 24 are perpendicular to the outer faces of the segments 14A-F.

The moulding 16 is positioned between the mouldings 18, 20. In this state, the entire outer face of segment 14A of moulding 16 is face-to-face with the entire outer face of segment 14D moulding 18. Similarly the entire outer face of segment 14C of moulding 16 is face-to-face with the entire outer face of segment 14F of moulding 20. The mouldings 16, 18 are joined together by suitable fastening means which, in the present case, may include bolts 26 (see Figure 12) that are positioned at intervals around the peripheries of the interfacing segments 14C, 14F and clamp them together. It is of course necessary to provide holes 28 in the wall 12 at the interfacing segments to accommodate the bolts. The mouldings 16, 20 are joined together in the same manner with the interfacing segments 14A, 14D clamped together.

It will often be necessary to cut registering holes 30, 32 in the interfacing segments of the walls of the mouldings 16, 18 to provide a doorway or other manhole for human access between the two mouldings. As noted, the manhole can be closed by a watertight door when the boat B is fitted out. Further bolts or other fastenings may be provided around the holes 30, 32 for clamping the interfacing segments together. Similar holes can be provided in the interfacing segments of the mouldings 16, 20.

The mouldings 36, 38 in the second group M2 are positioned in front of, and in alignment with the respective mouldings 18, 20. Each moulding 36, 38 also comprises a longitudinally extending, cylindrical side wall 12' which, at the rear end of the moulding, is of hexagonal cross section and embodies six segments 14A', 14B', 14C', 14D', 14E', 14F', equiangularly disposed one to the other. The segments extend forwardly from the rear ends of the mouldings 36, 38 in the fore-and-aft direction. Flat rear walls 24', integrally moulded with the walls 12, span the rear ends of the mouldings 36, 38. At the rear ends, the walls 24' are perpendicular to the wall 12' and more particularly to the outer faces of the segments 14A'-F'. Thus, where the mouldings 36, 38 meet the respective mouldings 18, 20, the outer faces of the segments 14A'-F' are coplanar with the outer faces of the respective segments 14A-F. However, forward of the rear ends of the mouldings, the profiles of the segments

14A'-F'differ from those of the respective segments 14A-F14 and also differ from each other as will be explained.

The single moulding 42 produced from the mould M4 is positioned in front of, and in alignment with the moulding 16. The moulding 42 also comprises a longitudinally extending, cylindrical side wall 12" which, at its rear end, is of hexagonal cross section and embodies six segments 14A", 14B", 14C", 14D"', 14E", 14F", equiangularly disposed one to the other. The segments extend forwardly from the rear end of the moulding 42 in the fore-and-aft direction. An integrally moulded flat rear wall 24" spans the rear end of the moulding 42. At this end, the wall 24" is perpendicular to the wall 12" and more particularly to the outer faces of the segments 14A"-F". Thus, where the moulding 42 meets the moulding 16, the outer faces of the segments 14A"-F" are coplanar with the outer faces of the respective segments 14A-F of moulding 16. However, forward of the rear end of the moulding 42, the profile of the segments 14A"-F"differ from those of the respective segments 14A-F14 of moulding 16 and also differ from each other as will be explained.

When the mouldings 36, 38, 42 are positioned as just described, due to their size and shape, the outer face of the segment 14F' (moulding 36) has a flat portion that meets a flat portion of the outer face of the segment 14C" (moulding 42) face-to-face. Similarly the outer face of the segment 14D' (moulding 38) has a flat portion that meets a flat portion of the outer face of the segment 14A" (moulding 42) face-to-face.

The mouldings 36, 38, 42 are joined to the respective mouldings 18, 20, 16 by suitable fastenings such as bolts 44 passing through holes 48 that are formed at intervals around the peripheries of the interfacing walls 24', 24", 22 and clamp them together. Similarly, the mouldings 36, 38, 42 are joined together by bolts 26 around the peripheries of the areas where the flat portions of the outer faces of the respective segments interface.

Again it will often be necessary to cut registering holes (such as 30', 30") in the walls of the respective mouldings where they interface. As before, bolts or other fastenings may be mounted provided around these registering holes for clamping the walls together.

In the present case, the vertical overall height of each of the mouldings in groups M1-M3 is 2.05 meters. Due to the nature of the rotational moulding process, each of these mouldings has a uniform wall thickness of about 3 cm all round. Allowing for the wall thickness, the internal vertical height of each moulding is thus 1.99 meters so that there is likely to be plenty of head room in each of the six mouldings, even allowing for the installation of a floor located above the bottom of the moulding when the boat B is fitted out. Any other suitable height could be chosen.

As noted, the assembly 10 is intended to be fitted out as a catamaran type boat B. In this configuration, the assemblies comprising the aligned moulding pairs 36, 18 and 38, 20 constitute the two hulls of the boat with the mouldings 36, 38 located at the forward ends of the hulls. For this reason, the segments 14A', 14C' of each of these mouldings taper inwardly towards their front ends as shown at 50. Similarly the horizontal segments 14B' located at the bottoms of the moulding 36, 38 taper upwardly towards their front ends as shown at 52. In both cases this is to promote a clean passage of the hulls through the water.

The hull assemblies are joined structurally together, and separated by, the assembly comprising the aligned moulding pair 42, 16 which is raised above the water. This assembly can be fitted out as a saloon with a steering- and control station at its forward end. For this reason, the moulding 42 is formed with a steeply sloping portion 54 that is disposed athwartships and extends between the segments 14D" and 14F". A hole 56 can be cut in this portion for accommodating a windscreen.

Even though the saloon assembly is raised above the water, good boat design may dictate that the horizontal segment 14B" located at the bottom of the moulding 42

should taper upwardly towards its front end as shown at 58. Again this is to promote a clean entry of the front end of boat B through any water that reaches the level of the saloon assembly as often happens at sea.

The horizontal upper segments 14E, 14E' and 14"' conveniently constitute substantial deck areas for the boat B. Access to these deck areas can be gained through, for example, doorways or manholes formed by holes 60 cut in the segments 14D, 14F of moulding 16 and/or in the segments 14D", 14F" of moulding 42. As before, these manholes can be sealed by watertight doors.

Further holes 62 can be cut in the segments 14D, 14D", 14F, 14F" to accommodate portholes of known type.

There are two mouldings 64, 66 in group M3, attached to the rear ends of the respective mouldings 18, 20. Although the mouldings 64, 66 are mutually identical, they differ somewhat from the mouldings in groups M1-M3 in that they are not of hexagonal cross section. Instead, each is of the shape of a half-hexagon of the same size as that of the mouldings in groups M1-M3. Thus moulding 64 comprises a longitudinally extending sidewall 12"' incorporating three segments 14A"', 14B"' and 14C"' of the same size as, and coplanar with, the respective segments 14A, 14B and 14C. Further, moulding 64 comprises a front wall 70 and a rear wall 72 each of which is perpendicular to the sidewall 68. Finally, moulding 64 comprises an upper wall 76 that extends between the upper ends of end walls 70, 72 and also between the upper ends of segments 14A"' and 14C"'. Moulding 64 (and similarly moulding 66) thus comprises a unitary enclosed shell when it is taken out of the mould M3. The front wall 70 is disposed face-to-face with the lower half of the rear wall 24 of moulding 18. As before, moulding 64 (and also moulding 66) is joined to moulding 18 by suitable fastenings such as bolts 44 that pass through holes positioned at intervals around the peripheries of the interfacing parts of walls 70, 24 and clamp them together. A hole for creating a manhole similar to those provided elsewhere, may be cut in the wall 70 and further holes for accommodating fastenings may be

drilled around the manhole for clamping the interfacing wall parts together. A hole 78 can be cut into the upper walls to constitute a hatch for giving access to the interior of moulding 64. The hatch can be closed by a watertight hatch cover of known type.

Each moulding 64, 66 can conveniently be designed to accommodate, in known manner, an engine and propeller shaft for boat B. Each propeller shaft would pass through a hole cut in the lower segment 14B"' of the mouldings. The hole would be closed by known means fixed to the segment 14B"' for housing a bearing and gland for the propeller shaft.

Figures 1-6 are drawn to the same scale and from this it can be seen that the overall length of the particular assembly 10 shown in Figures 1-6 is 13 meters, and the beam is 6 meters. Clearly, two or more sets of three M1 mouldings joined together as described above could be mounted end-to-end to increase the length of the assembly 10.

Because the outer faces of various wall segments are coplanar as described, such coplanar faces present a continuous smooth surface extending from the front of the boat to the back. As is well know, this is important for smoothing the passage of the hulls through the water.

An advantage of the invention is that the same mouldings can be used for boats and other floating structures of various shapes. For example, the mouldings heretofore described and illustrated in the drawings could be used to construct a hull-and-deck assembly 100 for a trimaran-type boat having the cross-sectional shape as shown in Figure 14 which is an entirely schematic end view of the rear of the assembly 100. Here a group of six of the mouldings from mould M1 are joined together as a sub-assembly 102 forming part of a boat with three hulls incorporating M1 mouldings 104, 106, 108. Because of the size of this boat, it may comprise two or more of such sub-assemblies 102 disposed one in front of the other. As in the case of boat B, mouldings from mould M2 may be mounted at the front of each of the mouldings

104-108 and a moulding from mould M4 may be mounted at the front of the central upper moulding 110. A moulding from mould M3 may also be mounted at the back end of each of the mouldings 104, 106,108.

Figure 15 is a similarly schematic view of an assembly 120 that is one example of a structure that could be used as a floating platform. In the present case, the assembly comprises three floating shells in the form of mouldings 122, 124, 126 from mould M1. The shells are spaced apart by two watertight shells in the form of two mouldings 128, 130 from mould M3 which, in use, are lifted above the water by the mouldings 122-126.

In one variation, the assembly 120 could be provided with additional mouldings 128', 130' from mould M3, located below the respective mouldings 128, 130.

In another variation, the assembly 120 could be inverted to act as one variation of the floating platform. In this version, all of the modules are located at water level and there would be two channel-like spaces 132 between the mouldings 122, 124, 126 which might make the platform particularly useful for some purposes

Figure 16 shows how a series of modules from moulds M1, M3 could be joined together to form an assembly 140 for a floating platform of any reasonable size and having a continuously flat upper surface or deck. As should be clear from the foregoing description, a series of the assemblies could be joined together honeycomb fashion to increase the size of the platform. In the assembly 140, the longitudinal axes of the mouldings are vertically disposed.

The useful shapes of the modules are not necessarily limited to those shown in the Figures discussed to this point. Figure 17 shows modules 150 from a single mould but having a non-symmetrical shape. Each module has two wall segments 152, 154 either of which can be brought face-to-face with a corresponding wall segment of the other module when the modules are joined together in the alternative configurations shown.

Those skilled in the art will be aware that it is necessary to provide elements such as stiffening ribs, gussets and the like at various places in the mouldings to give them adequate strength and also, for example, to prevent distortion of the plastics material as it cools in the mould. As is well known, these elements can be formed during the moulding process as integral parts of the moulding. By way of example, Figure 18 shows a wall segment (segment 14B in this instance) with integrally moulded, longitudinally extending ribs 99. These ribs serve to stiffen the wall segment and also to promote clean flow of water along the outer face of the segment when the moulding is incorporated in a boat hull.

The modules shown Figures 14-17 can be joined together in substantially the same manner as heretofore described with reference to the assembly 10. Those skilled in the art will be aware of alternative means of joining together any of the mouldings shown herein. Furthermore, the other features heretofore described that are incorporated in the assembly 10 may be replicated in each of the assemblies shown in Figures 14-17 and need not be repeated here.

One alternative means for joining the mouldings together is shown in Figure 13 and comprises a plate 90, also of plastics material, that overlaps a joint 92 between two mouldings. The walls of the mouldings may be provided with recesses 94 formed during the moulding process to accommodate the plate 90 which can be through bolted to the walls by bolts 96 or other fastenings.

Alternatively or in addition, two mouldings can be welded together at the joints therebetween, as shown at 98 in Figures 11 and 12. It may be difficult to achieve welded joints between two rotationally moulded components that, by themselves, are strong enough for practical purposes. However, such welded joints may be useful to make the joints watertight and also to give the joints a finished appearance.

The foregoing examples demonstrate that the mouldings described can be joined together in two or more different configurations to make up assemblies that can be used as boats or other floating structures. The mouldings are of moulded plastics material. Each of the mouldings has an outer face incorporating at least two zones that are so shaped that one moulding can be joined to another in at least two dispositions. In one of such dispositions, the first zone of one of the mouldings is in face-to-face relationship with one of the zones of another of the mouldings. In another of such dispositions, the second zone of the one moulding is in face-to-face relationship with one of the zones of the other moulding.

Moreover, such assemblies can be made up of three or more of the mouldings with outer faces shaped so that the mouldings can be similarly joined together.

It is not intended that recognised mechanical equivalents of and/or modifications of and/or improvements to any matter described and/or illustrated herein should be excluded from the scope of a patent granted in pursuance of any application of which this specification forms a part or which claims the priority thereof or that the scope of any such patent should be limited by such matter further than is necessary to distinguish the invention claimed in such patent from the prior art.